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Contribution to the study of gasteroid and secotioid fungi of Chihuahua, Mexico

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Abstract — Including the twenty-seven new records reported herein, fifty-seven taxa of gasteroid fungi are now known from Chihuahua. *Geastrum schmidelii* var. *parvisporum* represents a new record for the Mexican mycobiota. A nom. nov. is proposed for *Agaricus texensis,* which is an illegitimate later homonym. The species presented are annotated with observations on macro- and microscopic characters, and SEM photomicrographs illustrating spore and capillitial characters are included for selected taxa.

Key words — *Agaricomycetes*, *Gasteromycetes* sensu lato, chorology, taxonomy

Introduction

Chihuahua, the largest state in Mexico, is located in the north and bordered by the Mexican states of Sonora to the west, Durango to the south, and Coahuila to the east and by the U.S. states of Texas and New Mexico to the north. The predominant vegetation types found in the state are coniferous forest, oak forest, grassland, xerophytic scrub, and tropical deciduous forest (Rzedowsky 1978). Prior to this study, thirty-one gasteroid taxa had previously been reported from Chihuahua. Initial records for the state are contained in the publications that follow.

Guzmán & Herrera (1973): *Arachnion album* Schwein., *Battarreoides diguetii*, *Bovista pusilla* (Batsch) Pers., *Cyathus montagnei* Tul. & C. Tul., *Lycoperdon*

marginatum (as *L. candidum*), *Melanogaster umbrinigleba* Trappe & Guzmán, *Phallus impudicus* L., *Pisolithus arhizus* (as *P. tinctorius*), and *Scleroderma cepa*.

Pérez-Silva & Aguirre-Acosta (1986): *Agaricus aridicola* Geml et al. (as *Gyrophragmium dunalii*), *Calvatia cyathiformis* (Bosc) Morgan, *C. gigantea* (Batsch) Lloyd, *Crucibulum laeve* (as *C. vulgare*), *Cyathus olla* (Batsch) Pers., *Lycoperdon echinatum* Pers., *L. perlatum*, *L. umbrinum* Pers., *Melanogaster nauseosus* Coker & Couch, *Scleroderma verrucosum*, *Simblum texense* (G.F. Atk. & Long) Long, and *Tulostoma wrightii* Berk.

Laferriére & Gilbertson (1992): *Astraeus hygrometricus*, *Cyathus stercoreus*, *Disciseda hyalothrix* (as *D. pedicellata*), *Geastrum saccatum*, *G. triplex*, *Lycoperdon oblongisporum* Berk. & M.A. Curtis, *L. pyriforme*, and *Mycenastrum corium*.

Moreno-Fuentes et al. (1994): *Lycoperdon peckii* Morgan.

Quiñónez-Martínez et al. (1999): *Scleroderma areolatum*.

Materials and methods

Material for study was primarily collected by students of the Universidad Autónoma de Ciudad Juárez; however, one of us (ML) contributed several collections. The specimens are deposited in the Herbarium of the "Departamento de Ciencias Básicas, Universidad Autónoma de Ciudad Juárez" (cited here as UACJ; Mexico) and the Herbarium of the "Departamento de Biología Vegetal, Universidad de Alcalá, Madrid" (AH; Spain)

Microscopic characters (e.g., spore dimension, which includes ornamentation) were observed under the light microscope (Nikon Eclipse 80i) on material mounted in Hoyer's medium. Ultrastructural studies (e.g., spore ornamentation details) under the scanning electron microscope (SEM) were conducted on the specimens housed in Spain (AH). Samples were prepared according to the critical-point-drying method outlined in Moreno et al. (1995) and examined on a Zeiss DSM-950. Detailed descriptions, for the most part, are given only for species that represent new records for the state of Chihuahua.

Taxonomy

Agaricus deserticola G. Moreno, Esqueda & Lizárraga **nom. nov.**

MycoBank MB 516712

≡ *Secotium texense* Berk. & M.A. Curtis, Grevillea 2: 34 (1873)

≡ *Gyrophragmium texense* (Berk. & M.A. Curtis) Massee, Grevillea 19: 96 (1891)

≡ *Longia texensis* (Berk. & M.A. Curtis) Zeller, Mycologia 35: 414 (1943)

≡ *Longula texensis* (Berk. & M.A. Curtis) Zeller, Mycologia 37: 636 (1945)

≡ *Agaricus texensis* (Berk. & M.A. Curtis) Geml, Geiser & Royse, Mycol. Progr. 3: 172 (2004), nom. illegit., non *A. texensis* Berk. & M.A. Curtis (1853)

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Nuevo Relleno Sanitario, leg. R. Rivas, 2.VI.1996, *UACJ 1128* in *AH 38925*. Samalayuca, growing on sandy soil, leg. A. Gatica, 1.IV.2000, *UACJ 1129*. Parque El Chamizal, growing on soil, leg. H.A. Peña, 13.III.2001, *UACJ 1134* in *AH 38926*. Samalayuca, Rancho Zorro Plateado, growing on sandy soil, leg. F. Garcia & F. Piñera, 20.IV.2003, *UACJ 1127*. **Municipality of Ahumada**, Villa Ahumada, Rancho Santa Mónica, growing on sandy soil among *Poaceae* grasses, leg. J. Piñera, A. Fernández, M. Méndez, R. Castellanos & F. García, 1.III.2003, *UACJ 1132*. **Municipality of Chihuahua**, Rancho El Capricho, associated with *Ephedra* sp., leg. F. García A. Rodríguez, E. Orozco & A. Fernández, 30.IV.2003, *UACJ 1133*. **Municipality of Juárez**, Ciudad Juárez, urban zone next to Instituto Tecnológico de Cd. Juárez, associated with *Washingtonia filifera* (Linden ex André) H. Wendl., leg. M. Lizárraga & S. Escobar, 15.V.2006, *UACJ 1130*.

Observations — This species is characterized by a broadly globose 7–12 cm tall basidiome with a 2–4 × 6.5–9 cm pileus, peridial remains that typically form a membranous double annulus, a striate 6.5–8 × 2–4 cm stalk that extends as a percurrent columella through the pileus, and which lacks a volva. The basidiospores are 6–8 × 5–6 µm, subglobose to ovoid, smooth, very dark, and lack a germ pore.

Macro- and micro-morphological studies have been made previously on Mexican material from Baja California (Ochoa & Moreno 2006) and Sonora (Moreno et al. 2007). Molecular phylogenetic analyses support this secotioid fungus in *Agaricus*, a genus previously restricted to agaricoid forms (Geml et al. 2004). This is the first report of this taxon from Chihuahua.

Astraeus hygrometricus (Pers.) Morgan, J. Cincinnati Soc. Nat. Hist. 12: 20 (1889)

Specimens examined — **MEXICO. Chihuahua: Municipality of Ocampo**, Basaseachi, in pine-oak wood, leg. M. Lizárraga, 12.VIII.2001, *UACJ 1146* in *AH 37847*.

Observations — A capillitium that is hyaline, septate and with clamp connections and spores that are globose, 8–12(–13) µm in diam., and with pronounced verrucae characterize *A. hygrometricus*. Molecular studies (Phosri et al. 2007) support several species within *Astraeus*.

These include *A. odoratus* Phosri, M.P. Martín & Watling (Phosri et al. 2004) and *A. asiaticus* Phosri et al. (Phosri et al. 2007), which have been described from Asia, as well as *A. pteridis* (Shear) Zeller (= *Geastrum hygrometricum* var. *giganteum* Lloyd) that has previously been reported from Mexico (Phosri et al. 2007). Although the true identity of *A. hygrometricus* is not fully resolved (see Phosri et al. 2007), macro- and microscopic characters of the Chihuahuan material agree with those previously described under *A. hygrometricus* from Baja California (Ochoa & Moreno 2006). Several previous reports of "*A. hygrometricus*" have been made from Chihuahua (Laferriére & Gilbertson 1992; Quiñónez-Martínez et al. 1999, 2005; Quiñónez-Martínez & Garza-Ocañas 2003).

Battarrea phalloides (Dicks.) Pers., Syn. Meth. Fung. (Göttingen) 1: 129 (1801)
= *Battarrea stevenii* (Libosch.) Fr., Syst. Mycol. 3: 7 (1829)

Specimens examined — **MEXICO. Chihuahua: Municipality of Ascensión,** Ejido Pancho Villa, among litter under *Prosopis* sp., leg. A. Gatica, 14.V.2000, *UACJ 1160*. **Municipality of Casas Grandes**, Casas Grandes, leg. M. Andrew, 19.VIII.2001, *UACJ 1147*. Ibidem, 18.V.2002, *UACJ 1148*.

Observations — This species is characterized by a 20–42 cm tall basidiome with a spore sac that is 1–2 × 4–8 cm, subglobose-depressed and dehisces when mature by a circumscissile opening, a brown-ferruginous gleba, a 18–40 × 1–2 cm, woody, fibrous stipe, and a free, fragile, sac-shaped volva that measures up to 6 × 4 cm. Spores are 5–6 × 4–6 µm, globose to subglobose, verruculose, ochraceous and elaters are 3.5–7 µm in diam., very variable in length, spiralled, pale yellow, aseptate, and unbranched.

This species is highly variable in size and grows mainly in xerophytic areas. Macro- and microscopic characters agree with the description given by Moreno et al. (1995), which was based on collections from Baja California. This is the first report for this species from Chihuahua.

Battarreoides diguetii (Pat. & Har.) R. Heim & T. Herrera, An. Inst. Biol. Univ. Mex. 32: 30 (1962, "1961")

Specimens examined — **MEXICO. Chihuahua: Municipality of Ahumada**, Villa Ahumada, Rancho Santa Mónica, on sandy soil next to *Larrea tridentata* Coville and *Opuntia* sp., leg. F. García, A. Fernández, M. Méndez, E. Orozco & A. Fernández, 1.III.2003, *UACJ 1149*. Sierra Peñascos, leg. M. Vargas & M. Astorga, 15.IV.2006, *UACJ 1151*. **Municipality of Juárez**, Samalayuca, next to *Larrea tridentata*, leg. A. Gatica & J. Córdova, 24.V.2003, *UACJ 1150*.

Observations — This species is characterized by its 14–20 cm tall basidiome and spore sac that is 3–6 × 2.5–4 cm, subglobose-depressed, and dehisces at maturity through several pores all over the spore sac surface. Gleba brown-ferruginous. Stipe 13–19 × 1–1.3 cm, woody, fibrous. Volva up to 1.2 × 1 cm, sac-shaped, free, fragile. Spores 4–5 µm, globose to subglobose, verruculose, ochraceous. Elaters 2–7 µm in diam., length very variable, spiralled, pale yellow, aseptate and not branched.

A macro- and microscopical study of this monospecific genus including SEM photographs was made by Moreno et al. (1995). *Battarreoides diguetii* was previously reported for Chihuahua by Guzmán & Herrera (1973) and Pérez-Silva & Aguirre-Acosta (1986).

Bovista aestivalis (Bonord.) Demoulin, Beih. Sydowia 8: 143 (1979)
≡ *Lycoperdon aestivale* Bonord., Handb. Allgem. mykol.: 251 (1851)
= *Lycoperdon polymorphum* Vittad., Monograph Lyc.: 39 (1842), nom. illegit., non *L. polymorphum* Scop. (1772)

Specimens examined — **MEXICO. Chihuahua: Municipality of Guachohi**, Cusarare, in pine-oak wood, leg. C. Mass & V. Manriquez, 12.VIII.2001, *AH 37830*. **Municipality of Bocoyna**, San Juanito, next to *Pinus* sp., leg. M.C. Natividad, B. Marín & M. Ángeles, 11.VIII.2001, *AH 37831*. **Municipality of Madera**, Presa Las Peñitas, in pine wood, leg. J. Vargas & J.M. Muñoz, 22.VIII.2003, *AH 37828*. **Municipality of Chihuahua**, Cumbres de Májalca, growing amid leafy debris under *Cupressus* sp. and *Quercus* sp., leg. M. Lizárraga, 15.XI.2003, *AH 37829*, *AH 37832*.

Observations — Macroscopically, this species is characterized by a granulose to spinulose exoperidium that sloughs off easily and a conspicuous mycelial cord that persists at the base. Microscopically, *B. aestivalis* exhibits a capillitium of the intermediate-type, having yellowish, straight (rarely undulate), fragile, thick-walled capillitial threads (4–6 µm in diam.) with numerous large (up to 1 µm in diam.) pits. The spores of *B. aestivalis* are smooth to verruculose (under LM) and globose (4–5 µm in diam.).

A study of this species including SEM micrographs was made by Ochoa & Moreno (2006) based on collections from Baja California. Molecular studies (Larsson & Jeppson 2008, Bates et al. 2009, Larsson et al. 2009) confirmed the identity of this species and its taxonomic position within the genus *Bovista* Pers. This is the first report of *B. aestivalis* from Chihuahua.

Bovista fusca Lév., Ann. Sci. Nat., Bot., Sér. 3, 5: 303 (1846) Figs. 1–3

= *Bovista ruizii* T. Herrera, Ann. Inst. Biol. Univ. Mexico 30: 35 (1960, "1959")

Specimens examined — **MEXICO. Chihuahua: Municipality of Guachochi**, Cusarare, leg. F. Piñera & R. Castellanos, 10.IV.2003, in pine-oak wood, *UACJ 1121* in *AH 37837*.

Observations — A single mature, globose (2.5 cm in diam.) basidiome was collected that exhibited an irregular, apical ostiole. Its exoperidium was absent, and the endoperidium was membranous, smooth, dark reddish-brown. Microscopically, the specimen exhibited reddish-brown capillitium of the *Bovista*-type with thick-walled (8–17 µm in diam.), highly branched capillitial threads with long tapering tips. The spores were ovoid to subglobose (4.5–5.5 × 3.5–4.5 µm), smooth to minutely ornamented (under LM), with hyaline, more-or-less truncate, pedicels (8–16.5 µm long). Under SEM the spores exhibited abundant, truncate verrucae that were variable in size, irregularly distributed, and occasionally joined apically to form short ridges.

The macro- and microscopic characters of our specimen agree with those given in the protologue of *Bovista ruizii* (Herrera 1960), a species described from Mexico that was later synonymized with *B. fusca* (Kreisel 1967). *Bovista fusca* is similar to *B. nigrescens* Pers., described from Europe and Asia; however that species has globose to subglobose spores (4.2–6 µm in diam.) and shorter (4–9 µm in length) pedicels (Kreisel 1967). Reports of *B. nigrescens* from Mexico

(Calonge et al. 2004) were later corrected to *B. fusca* (Calonge et al. 2005). This is the first report of *Bovista fusca* from Chihuahua.

Calvatia fragilis (Vittad.) Morgan, J. Cincinnati Soc. Nat. Hist. 12: 168 (1890)

Figs. 4–6

Specimens examined — **MEXICO. Chihuahua: Municipality of Janos**, 4.3 km to southwest of Rancho La Garrapata way, Sierra de En Medio, leg. M. Lizárraga, 1.X.2005, *UACJ 1154* in *AH 37840*.

Observations — The single collection made consisted of weathered specimens with small subgleba as well as lilac toned endoperidia and glebal remnants. Microscopically, the specimens exhibited ochraceous-yellowish, septate, fragile capillitial threads (2–5 µm in diam.) with numerous small pores. The spores were ochraceous, globose (5–7 µm in diam.), and spinulose, with ornamentation consisting of irregular to coralloid-shaped spines. Under SEM, occasional short, thin ridges that join the spines at their bases can be observed.

The closely related *Calvatia cyathiformis* can be distinguished from *C. fragilis* by its well-developed cellular subgleba with violaceous tones. Detailed descriptions have been made of *C. fragilis* collections from nearby areas, such as Baja California (Ochoa & Moreno 2006) and Arizona, USA (Bates et al. 2009). Previous reports of *Calvatia cyathiformis* from Chihuahua exist (Pérez-Silva & Aguirre-Acosta 1986, Laferriére & Gilbertson 1992). Some authors synonymize these species; however, both are valid species. *Calvatia fragilis* is reported here for the first time for Chihuahua.

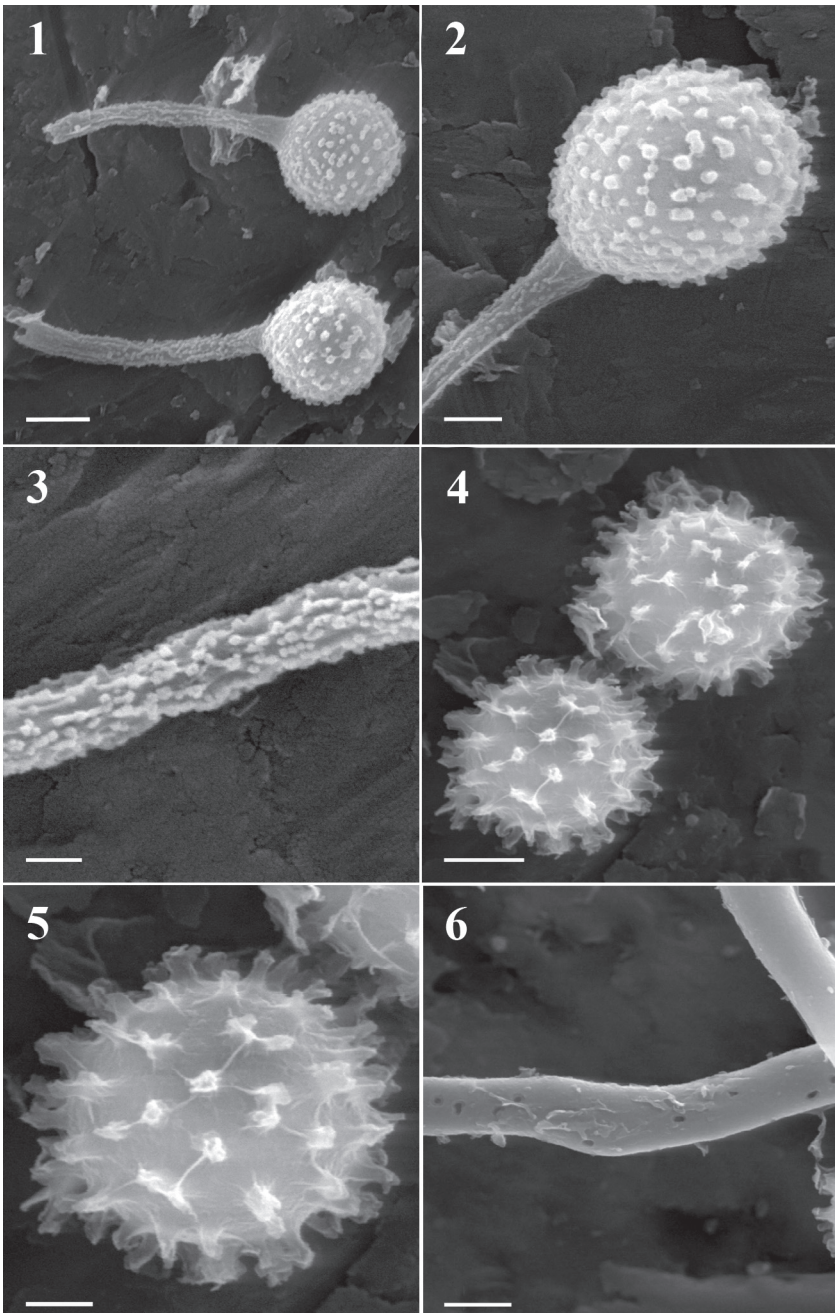
Crucibulum laeve (Huds.) Kambly, Gast. Iowa: 167 (1936)

Specimens examined — **MEXICO. Chihuahua: Municipality of Bocoyna**, San Juanito, on cow dung, leg. M. Vargas & M, Andrew, 11.VIII.2001, *UACJ 1125*. **Municipality of Chihuahua**, Cumbres de Majalca, on decayed wood of *Quercus* sp., leg. M. Lizárraga & G. Márquez, 15.XI.2003, *UACJ 1124*.

Observations — This species is clearly characterized by its sessile, cyathiform, 3–7 × 5–8 mm basidiome that, when young, is covered by an orange yellowish tomentum that is lost at maturity. Peridioles are numerous, lenticular, 3–6 × 1–2 mm, and whitish with a funiculus while basidiospores are 7–9 × 4–6 µm, ellipsoid, hyaline, and smooth.

This cosmopolitan species was previously cited from Chihuahua by Pérez-Silva & Aguirre-Acosta (1986), Laferriére & Gilbertson (1992), and Quiñónez-Martínez et al. (1999).

Figs. 1–3: *Bovista fusca* AH 37837, 1. Spores. 2. Spore ornamentation detail. 3. Spore pedicel ornamentation detail. Figs. 4–6: *Calvatia fragilis* AH 37840. 4. Spores. 5. Spore ornamentation detail. 6. Pitted capillitium. Scale bar 1, 4, 6 = 2 µm; 2, 5 = 1 µm; 3 = 0.5 µm.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Cyathus stercoreus (Schwein.) De Toni, Syll. Fung. (Abellini) 7: 40 (1888)

Specimens examined — **MEXICO. Chihuahua: Municipality of Bocoyna**, San Juanito, on cow dung, leg. M. Lizárraga, 11.VI.2001, *UACJ 1123* in *AH 37842*.

Observations — Basidiomes abundant on dung, morphology variable, in general conical and with a basal zone or with a conspicuous pedicel; exoperidium hairy and shaggy when young but becoming smooth, yellowish brown to brown with age. Endoperidium smooth, dark gray. Peridiole black, 1.5–3 mm in diam., double-walled and without a tunica, with a whitish funiculus. Spores of 22–28(–30) × 18–25(–28) µm, globose to subglobose or broadly ellipsoid, subhyaline, thick-walled up to 3 µm.

Cyathus pictus H.J. Brodie, which has large spores similar to those of *C. stercoreus*, grows on decayed *Eucalyptus* wood. *Cyathus pictus* is known only from Mexico, while *C. stercoreus* has a worldwide distribution (Brodie 1975). Laferriére & Gilbertson (1992) and Quiñónez-Martínez et al. (1999) previously reported *C. stercoreus* from Chihuahua.

Disciseda candida (Schwein.) Lloyd, Mycol. Writ. 1: 100 (1902)

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Km 30 Ciudad Juárez to Casas Grandes road, next to *Prosopis glandulosa* Torr. and *Larrea tridentata*, leg. J. Carrasco, 20.X.2006, *UACJ 1155* in *AH 37815*

Observations — One basidiome was studied: subglobose, endoperidium light gray, fibrillose ostiole, spores globose to subglobose, 4–5 µm in diam., asperate to verruculose. Capillitium 3–4 µm in diam., hyaline, yellowish, with septa and pores.

Ochoa & Moreno (2006) published a morphological study (including SEM photos of the ornamented spores) of this species based on collections from Baja California. This is the first report of *D. candida* for Chihuahua.

Disciseda hyalothrix (Cooke & Massee) Hollós, Növ. Közl. 1: 107 (1902)
= *Disciseda pedicellata* (Morgan) Hollós, Term. Füz. 25: 103 (1902)

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Km 10 to San Jerónimo, on sandy and calcareous soil, leg. R. Martínez-Contreras, 23.III.2002, *UACJ 1082* in *AH 37816*.

Observations — In Mexico, *D. hyalothrix* has previously been reported from arid zones in Baja California (Ochoa & Moreno 2006) and Sonora (Moreno et al. 2007). It is characterized by large, strongly ornamented spores [(6–) 7–8 µm in diam.] with episporial spines that are apically fused and form flat tipped processes that are easily observed under phase contrast microscopy or (more clearly) under SEM.

The spores consistently exhibit pedicels that vary in length as the fungus matures; however, climatic conditions may also play a role in the variation

observed. The Chihuahuan spores typically have pedicels that are approximately 2 µm long, although longer (≤ 4 µm) pedicels were also observed. Comparison of the type specimens of *Disciseda hyalothrix* and *D. pedicellata* by Moreno et al. (2003) concluded that these species are conspecific.

Laferriére & Gilbertson (1992) were the first to report *D. hyalothrix* from Chihuahua.

Disciseda verrucosa G. Cunn., Trans. & Proc. New Zealand Inst. 57: 205 (1926)
= *Disciseda arida* Velen., Novit. Mycol.: 169 (1939).

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Dunas de Samalayuca, on sandy soil, leg. A, Gatica, 31.III.2000, *UACJ 1081* in *AH 37822*. **Municipality of Janos**, Km 100 Janos to Agua Prieta road, next to *Acacia* sp., leg. M. Lizárraga, 17.VIII.2008, *UACJ 1170* in *AH 37821*.

Observations — This species is clearly characterized by its 9–10 µm broad spores that are conspicuously ornamented with obtuse finger-like processes, typically curved at their apices (Pérez-Silva et al. 2000, Moreno et al. 2007).

This is the first report of *D. verrucosa* from Chihuahua. Bates et al. (2009) report this species from Arizona, but most North American records of are from Mexico (Sonora).

Geastrum fornicatum (Huds.) Hook., Curtis Fl. Londin. 4: 575 (1821)

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez,** Ciudad Juárez to Chihuahua road, under *Acacia* sp., leg. L.A. Rivera, 24.IV.2007, *UACJ 1099* in *AH 37857*.

Observations — The single basidiome collected possessed four rays supporting the endoperidial body and lacked the exoperidial mycelial layer. The endoperidial body is globose with a narrowly conical, truncate, fibrillose peristome that is lighter than the endoperidium but not distinctly delimited. The spores are globose (4.5–5 µm in diam.) and ornamented with conspicuous verrucae.

Geastrum quadrifidum Pers. is another species with a fornicate gastrocarp; however, this species has a distinctly delimited peristome and larger spores (5.5–6.5 µm in diam.). *Geastrum leptospermum* G.F. Atk. & Coker is another closely related fornicate species that has smaller spores [(3–)3.5(–4) µm in diam.] that are less coarse than those of *G. fornicatum* (see Sunhede 1989). The also closely related *G. jurei* Lazo, described from a single basidiome collected in Chile, is differentiated by its non-delimited peristome that is noticeably lighter than the endoperidium (Lazo 1972). More new collections are needed to determine its taxonomic delimitation.

We report *G. fornicatum* from Chihuahua for the first time here.

Geastrum saccatum Fr., Syst. Mycol. 3: 16 (1829)

Specimens examined — **MEXICO. Chihuahua: Municipality of Ocampo**, Basaseachic, on litter in pine-oak wood, leg. C. Salazar & D. Mejia, 8.X.2004, *UACJ 1103* in *AH 37851*. **Municipality of Madera**, Presa Peñitas, on litter in pine-oak wood, leg. A. Santiesteban, M. León, J. Carrasco & L. Grimaldo, 15.IX.2007, *UACJ 1161* in *AH 37849* and *UACJ 1107* in *AH 37850*.

Observations — This species is characterized by basidiomes with sessile, globose endoperidial bodies with fibrillose, distinctly delimited, occasionally recessed peristomes, non-hygroscopic rays, and 4–6 µm broad spores with pronounced verrucae.

Laferriére & Gilbertson (1992) previously reported *Geastrum saccatum* from Chihuahua.

Geastrum schmidelii **var. *parvisporum*** G. Moreno, Altés & Dios, Micologia 2000 (Trento), Ass. Micol. Bresadola: 159 (2000) Figs. 7–9

Specimens examined — **MEXICO. Chihuahua: Municipality of Cusihuriachi**, San Bernabé, amid leafy debris of *Quercus* sp. and *Cupressus* sp., leg. E. Orozco, 12.IV.2003, *AH 37848*.

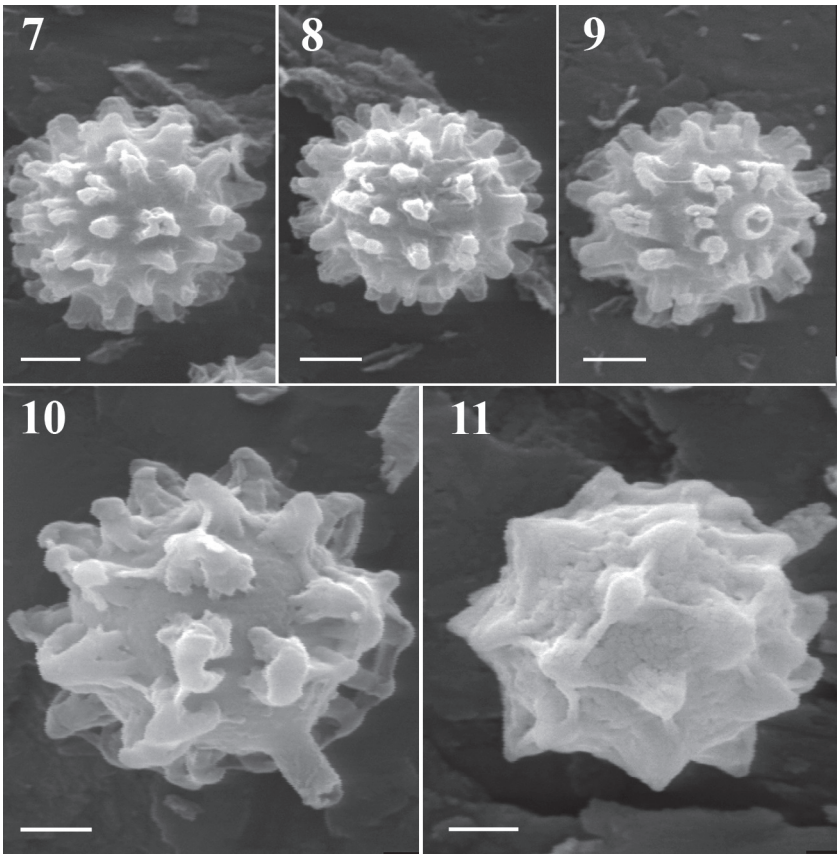
Observations — This species is characterized by non-hygroscopic rays, globose endoperidial bodies with short stalks that are covered with a fine pruinose layer, and recessed, plicate peristomes that are distinctly delimited by a rim. The 4.5–5(–5.5) µm broad spores possess dense, truncate verrucae.

The small spore size and other features observed in the Chihuahuan material agree with the description by Dios et al. (2000) of the same variety from Argentina (Dios et al. 2000). This taxon includes American material previously reported as *G. schmidelii* (Lloyd 1902, Coker & Couch 1928, Ponce de León 1946, Smith 1951) with spore dimensions that rarely exceed 5 µm in diam. However the spore dimensions cited for Arizonian material of *G. schmidelii* are (4.8–)5.6–6.4(–7.0) µm in diam., see Bates (2004). In contrast, European collections (*G. schmidelii* var. *schmidelii*) typically have larger spores [4.5–6.6 (–7) µm]. Under SEM, the spores exhibit long, slender, truncate verrucae, which are occasionally joined at their apices to form irregular-shaped ridges.

Geastrum schmidelii var. *parvisporum* is reported here for the first time from Mexico.

Geastrum triplex Jungh., Tijdschr. Nat. Gesch. Physiol. 7: 287 (1840)

Specimens examined — **MEXICO. Chihuahua: Municipality of Guachochi**, Cusarare, on litter of *Pinus* sp., leg. M. Lizárraga, 6.V.2000, *UACJ 1100* in *AH 37854*. **Municipality of Ocampo**, Basaseachic, on litter of *Pinus* sp., leg. M. Lizárraga, 12.VIII.2001, *UACJ 1098* in *AH 37853*. Ibidem, 8.X.2004, on leaf debris of *Quercus* sp., leg. E. Soto, N. Silva & M. Lizárraga, *UACJ 1101* in *AH 37856*. **Municipality of Bocoyna**, San Juanito, on litter in pine-oak wood, leg. C. Hernández-Ogaz, 15.IX.2006, *UACJ 1174* in *AH 37855*.



Figs. 7–9: *Geastrum schmidelii* var. *parvisporum* AH 37848. Spores. Figs. 10–11: *Lycoperdon atropurpureum* AH 37811. Spores. Scale bar 7–11 = 1 μm.

Observations — *Geastrum triplex* is characterized by its large size, non-hygroscopic rays, prominent pseudoparenchymatous collar, sessile endoperidial body that lacks an apophysis, and a distinctly delimited fibrillose peristome. Its 4–5 μm broad basidiospores possess dense, truncate verrucae.

This species is commonly found in Mexico (Calonge et al. 2004), and it was first reported for Chihuahua by Laferriére & Gilbertson (1992).

Geastrum xerophilum Long, Mycologia 34: 13 (1942)

= *Geaster pluriosteum* Long & Stouffer, Mycologia 40: 553 (1948)

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Km 30 Ciudad Juárez to Casas Grandes road, in xerophytic area with *Larrea tridentata*, leg. J. Carrasco, 20.X.2006, *UACJ 1106* in *AH 37852*.

Observations — Basidiomes of *G. xerophilum* have subsessile, densely to minutely furfuraceous endoperidial bodies (1–2 cm in diam.) with short stipes, endoperidia that split into 6–7 rays (typically recurved at their tips and closely surrounding the endoperidial body at its base), a brownish gray gleba, and non-delimited, small, truncate, applanate to conical plicate peristomes that are concolorous with endoperidium. Microscopically, *G. xerophilum* exhibits glabrous, aseptate, unbranched capillitium (3–4 µm in diam.) that lack pores and globose, verrucose spores (4–5 µm in diam.) with dense, truncate verrucae.

This is the first report of *Geastrum xerophilum* from Chihuahua. It was previously reported in Mexico from the states of Morelos and Sonora (Pérez-Silva et al. 1999).

Lycoperdon atropurpureum Vittad., Monograph Lyc.: 42 (1842) Figs. 10–11

Specimens examined — **MEXICO. Chihuahua: Municipality of Bocoyna**, San Juanito, in pine wood, leg. H.A. Peña, 10.VIII.2001, *UACJ 1152* in *AH 37807*. Lago de Arareco, in pine-oak wood, leg. M. Andrew & M. Vargas, 11.VIII.2001, *UACJ 1153* in *AH 37808*. **Municipality of Guachochi**, Cusarare, in pine-oak wood, leg. C. Mass & V. Manriquez, 12.VIII.2001, *UACJ 1173* in *AH 37811*. **Municipality of Ocampo**, Basaseachic, in pine-oak wood, leg. E. Pedroza, 10.VIII.2002, *UACJ 1109* in *AH 37810*. **Municipality of Chihuahua**, Cumbres de Majalca, in cypress-oak wood, leg. M. Lizárraga, 15.XI.2003, *UACJ 1117* in *AH 37809*.

Observations — *Lycoperdon atropurpureum* is characterized by a gleba with purplish to violaceus tinges, an alveolate, well-developed subgleba, and exoperidia with well-formed, brown, slender, simple, fragile spines. Microscopically, the species exhibits a *Lycoperdon*-type capillitium of reddish brown, thick-walled capillitial threads with abundant, small pores and 4.5–6 µm broad, globose, coarsely verrucose basidiospores. Under the SEM, stout, conical spines can be observed on the spores.

Although Kreisel (1973), (Ortega et al. 1985), and Calonge (1998) regarded *L. decipiens* and *L. atropurpureum* as synonyms, Jeppson (1987) and Jeppson & Demoulin (1989) disagreed. Recent molecular studies have confirmed that the two species are distinct (Larsson & Jeppson 2008).

Although previous records of this taxon from Mexico exist (Calonge et al. 2004), it is reported here for the first time from Chihuahua.

Lycoperdon eximium Morgan, J. Cincinnati Soc. Nat. Hist. 14: 15 (1891)

Figs. 12–13

Specimens examined — **MEXICO. Chihuahua: Municipality of Ocampo**, Basaseachic, in pine wood, leg. M. Hernández, 22.VIII.2002, *UACJ 1108* in *AH 37859*.

Observations — Basidiomes pyriform, 3.5 cm high × 2.5 cm diam. Exoperidium comprising small, isolated verrucae and small, dark brown spines,

occasionally joined apically with other spines. Endoperidium membranous, light brown. Gleba brown with lilaceous tones. Subgleba well-developed, 1.3 cm in length and 2 cm broad, cellular; cells up to 1 mm in diam. Capillitium of the *Lycoperdon*-type; capillitial threads 2–5 µm in diam., reddish brown, pitted. Spores 5–6 × 4–5 µm, ellipsoid, or rarely subglobose, smooth to verruculose, with a short pedicels. Spore ornamentation formed of abundant, dense verrucae, occasionally joined at their tips to form short ridges.

Our collection agrees well with the description of Coker & Couch (1928). This species is characterized by its cellular, well-developed subgleba, *Lycoperdon*-type capillitium, pored capillitial threads, and ellipsoid spores. *Lycoperdon eximium* is similar to *L. oblongisporum*, which Kreisel (1967) transferred to *Bovista* as *B. longispora* Kreisel, the epithet "*oblongispora*" having been used previously by Bottomley (1948) and thus not available. Although both *B. oblongispora* (Lloyd) Bottomley and *B. longispora* have ellipsoid spores, both species have very little to absent subgleba (Dennis 1953).

Previous records of *Lycoperdon eximium* from Valle de México exist (Herrera 1963); however, it is reported here for the first time from Chihuahua.

Lycoperdon lividum Pers., J. Bot. (Desvaux) 2: 18 (1809)

Specimens examined — **MEXICO. Chihuahua: Municipality of Bocoyna**, San Juanito, under *Pinus* sp., leg. M.C. Natividad, B. Marín & M.A. Samaniego, 11.VIII.2001, *UACJ 1115* in *AH 37858*.

Observations — Recognized by its pale brown, slightly granulose exoperidium; gleba greenish, subgleba alveolate, capillitium with abundant pores and 4.5–5.5 µm broad, rugose basidiospores.

Recently reported from the Mexican states of Baja California, Jalisco, Oaxaca, Tlaxcala, and Veracruz (Calonge et al. 2004), *L. lividum* is reported here for the first time from Chihuahua.

Lycoperdon marginatum Vittad. ex Moris & De Not., Fl. Caprar.: 226 (1839)

Specimens examined — **MEXICO. Chihuahua: Municipality of Bocoyna**, San Juanito, under *Pinus* sp., leg. M.C. Natividad, B. Marín & M.A. Samaniego, 11.VIII.2001, *AH 37819*. Ibidem, leg. A. Franco & J. Muñoz, 8.IX.2002, *UACJ 1113* in *AH 37820*.

Observations — *Lycoperdon marginatum* is principally recognized by its exoperidium with pyramidal verrucae (frequently composed 3–5 apically convergent spines) and that sloughs off the exoperidium in small plates as the fungus matures. This species is microscopically distinguished by verruculose spores that measure (3.2–)4.0–4.8(–5.6) µm in diam.

In their SEM examinations, Ochoa & Moreno 2006 observed no significant spore ornamentation differences in the Mexico and Spain collections. Laferriére & Gilbertson (1992) previously reported *L. marginatum* from Chihuahua.

Lycoperdon perlatum Pers., Observ. Mycol. (Lipsiae) 1: 4 (1796)

Specimens examined — **MEXICO. Chihuahua: Municipality of Ocampo**, Basaseachic, on litter in pine-oak wood, leg. J. Aguilar, 26.VIII.2002, *UACJ 1157* in *AH 37817*.

Observations — This species is easily recognized by its exoperidium of fragile, conical spines surrounded by a persistent, circular row of warts resembling a pearl necklace, a *Lycoperdon*-type capillitium with pores, and globose, 3.5–4.5 µm broad, verrucose spores.

Lycoperdon perlatum has been frequently cited in the Mexican mycobiota (Calonge et al. 2004). Reported from Chihuahua by Pérez-Silva & Aguirre-Acosta (1986), Quiñónez-Martínez et al. (1999, 2005), and Quiñónez-Martínez & Garza-Ocañas (2003).

Lycoperdon pyriforme Schaeff., Fung. Bavar. Palat. 4: 128 (1774)

≡ *Morganella pyriformis* (Schaeff.) Kreisel & D. Krüger, Mycotaxon 86: 175 (2003)

Specimens examined — **MEXICO. Chihuahua: Municipality of Ocampo**, Basaseachic, on decaying *Pinus* sp. wood, leg. M. Lizárraga & J. Vargas, 6.V.2000, *UACJ 1111* in *AH 37823*.

Observations — This species is recognized by its typically pyriform basidiomes with abundant, whitish, basal mycelial cords and its characteristic lignicolous habitat. The exoperidium is verruculose-granulose and spores are 3–4 µm in diam. and smooth to verruculose.

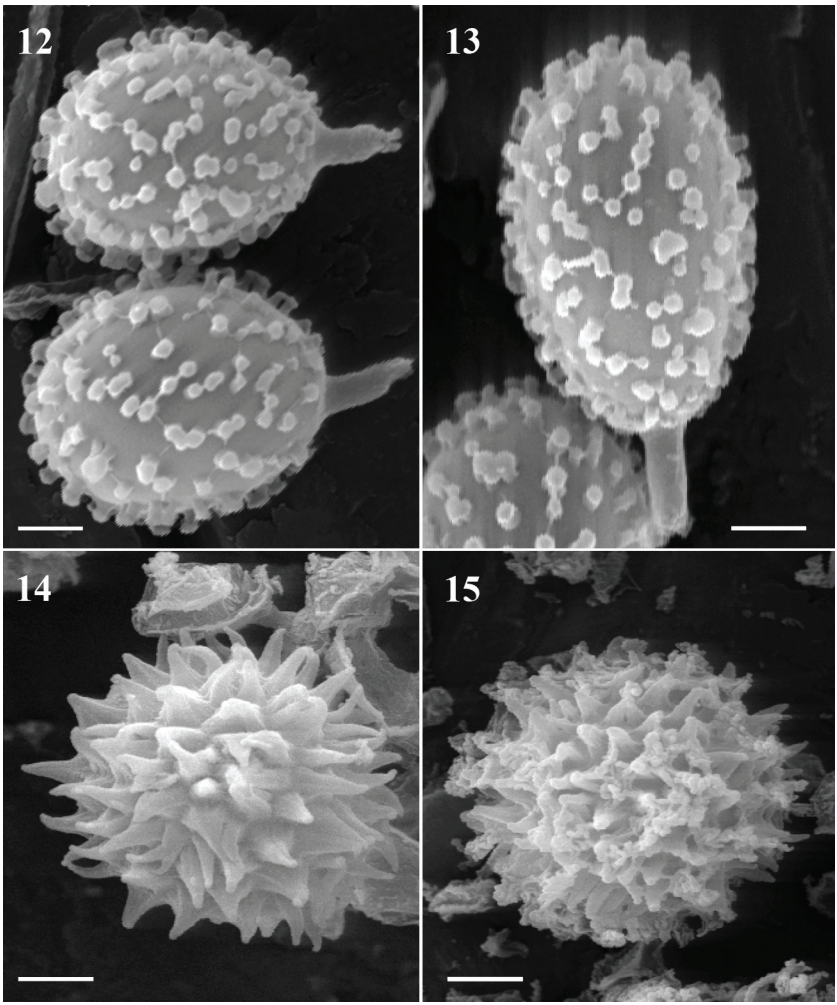
Krüger & Kreisel (2003) placed this species in *Morganella* Zeller (as *M. pyriformis*) based on molecular data. The molecular phylogenetic study of Larsson & Jeppson (2008), which included a broader sample of species in *Lycoperdaceae*, retains this species in *Lycoperdon*. Ochoa & Moreno (2006) studied spores of material from Baja California under SEM.

Lycoperdon pyriforme was first reported from Chihuahua by Laferriére & Gilbertson (1992).

Montagnea arenaria (DC.) Zeller, Mycologia 35: 418 (1943)

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Km 10 Ciudad Juárez to Janos road, next to *Larrea tridentata*, leg. M. Lizárraga, 26.VIII.2000, *UACJ 1140*. Km 12 San Jerónimo to Cd. Juárez road, in sandy soil, leg. A. Franco & S. Escobar, 17.IX.2002, *UACJ 1141*. Samalayuca, Rancho El Zorro Plateado, leg. F. García & F. Piñera, 24.V.2003, *UACJ 1142* in *AH 37839*. Sierra de Juárez, in sandy soil, leg. A. Aguirre, 9.XII.2006, *UACJ 1138*. Sierra de Samalayuca, in sandy soil, leg. C. Salazar, 16.III.2007, *UACJ 1137*.

Observations — *Montagnea arenaria* is characterized by its pileus having an apical disc, radial gills, a hymenophore, and spores with a prominent germ pore.



Figs. 12–13: *Lycoperdon eximium* AH 37859. 12. Spores. 13. Spore ornamentation detail. Fig. 14: *Scleroderma areolatum* AH 37813. Spore. Fig. 15: *S. verrucosum* AH 37814. Spore. Scale bar 12–13 = 1 μm; 14–15 = 2 μm.

Hopple & Vilgalys (1999) studied the taxonomic position of *Montagnea* Fr.; their sequence analyses placed *M. arenaria* in the same clade as *Podaxis pistillaris* and members of *Coprinus* section *Comati* and the genus *Leucocoprinus,* thereby confirming the hypothesis of Singer (1986).

Spore sizes [(6–)7–8(–9) × (4–)5(–6) µm] in the collections studied here differ from those reported by Dios et al. (2001) based on Argentine collections (13–16 × 10–12 µm). This variation in spore size is frequently found among basidiomes in the same collection. Chen (1999) concluded in a study of the genus that "there is extraordinary variation in the size and shape of the fruiting bodies and spores of *Montagnea*" and indicated a wide spore size variation of 7–22 × 4.5–14 µm.

Although it is frequently observed in xerophytic areas of Chihuahua, this is the first published report of *Montagnea arenaria* for Chihuahua.

Mycenastrum corium (Guers.) Desv., Ann. Sci. Nat., Bot., Sér. 2, 17: 147 (1842)

Specimens examined — **MEXICO. Chihuahua: Municipality of Casas Grandes**, Casas Grandes, in grassland, leg. M. Andrew & M. Vargas, 19.VIII.2001. *UACJ 1144*. **Municipality of Juárez**, Ciudad Juarez, in Escuela de Veterinaria Inst. Ciencias Biomédicas, a garden, leg. S. Escobar & M. Lizárraga, 13.VI.2006, *UACJ 1145*.

Observations — Recognized by its thick peridium which stelliform splitting at apical portion, spores 8–12 µm in diam., reticulate and capillitium cyanophilous with numerous spinose projections. This taxon was first reported for Chihuahua by Laferriére & Gilbertson (1992).

Pisolithus arhizus (Scop.) Rauschert, Z. Pilzk. 25: 51 (1959)

= *Pisolithus tinctorius* (Pers.) Coker & Couch, Gast. East. U.S. Canada: 170 (1928)

Specimens examined — **MEXICO. Chihuahua: Municipality of Janos**, Presa Casa de Adobe, in riparian vegetation next to *Quercus* sp., leg. J. Martínez, S. Herrera & I. Márquez, 22.III.2001, *UACJ 1158*. **Municipality of Chihuahua**, Km 80 Namiquipa to Chihuahua way, next to *Quercus* sp., leg. S. Herrera, 28.VIII.2003, *UACJ 1159*. **Municipality of Madera**, Presa Peñitas, leg. M. Lizárraga, 23.VIII.2003, next to *Quercus* sp., *UACJ 1160*.

Observations — This taxon is recognized by its 9–13 µm broad, globose, spinulose basidiospores.

Pisolithus arhizus has been frequently reported for Mexico and is mainly associated with *Pinus* and *Quercus* (Calonge et al. 2004). It forms a complex comprising several taxa that are easily differentiated at the molecular level, but not morphologically.

Guzmán & Herrera (1973) previously reported *P. arhizus* from Chihuahua.

Podaxis pistillaris (L.) Fr., Syst. Mycol. 3: 63 (1829)

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Ciudad Juárez, urban zone, next to *Prosopis* sp., leg. J. Martínez, 15.VI.2001, *UACJ 1137*. Campus del Instituto de Ciencias Biomédicas, Univ. Autónoma Ciudad Juárez, in sandy soil, leg. I. Márquez y J. Martínez, 25.VIII.2001, *UACJ 1522*. Ibidem, associated with *Larrea tridentata*, leg. I. Baca & W. Coronado, 13.VIII.2002, *UACJ 1136*. Km 12 San Jerónimo to Juárez road, associated with *Larrea tridentata*, leg. A. Franco, J. Soto &

S. Escobar, 17.IX.2002, *UACJ 1138*. Samalayuca, Rancho Zorro Plateado, in sandy soil, leg. J. Córdoba, 25.V.2003, *UACJ 1139*.

Observations — Recognized by its basidiome dehiscence by an irregular rupture at pileus base, spores 9.5–17 × 8.5–13.5 µm, broadly ellipsoid to oval, with a thick double-walled, prominent germ pore.

The large variability in basidiome and spore size exhibited by *Podaxis pistillaris* has produced taxonomic confusion.

A solitary to gregarious species typical of xeric areas, *P. pistillaris* is commonly found in the Municipality of Juárez, including urban zones. This is the first report from Chihuahua.

Schizostoma laceratum (Ehrenb. ex Fr.) Lév., Ann. Sci. Nat., Bot., Sér. 3, 5: 163 (1846), as "*lacerum*"

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Samalayuca, in sandy soil, leg. M. Lizárraga, 4.III.2001, *UACJ 1135* in *AH 37846*. **Municipality of Cuahutemoc**, Rancho El Castillo, located between Coyame and Cuauhtémoc, in xeric area with *Larrea tridentata* and *Prosopis* sp. leg. J. Vargas, *UACJ 1143*.

Observations — Two collections of isolated specimens. Basidiome stipitate, up to 6.3 cm total tall. Spore sac subglobose of 1.5–2 × 2–2.5 cm, with a petalloid dehiscence produced by irregular fissuring downwards from the apex. Stipe white, 3–4 × 0.3–0.6 cm, which goes inside spore sac such as a columella. Exoperidium not observed. Capillitium 4–10 µm in diam., reddish brown to ochraceous red, with isolated filaments, thick-walled, with short and scarce branches which have obtuse endings; capillitium remains in the endoperidium and columella wall when maturing. Spores of 5–5.5 µm in diam., globose to subglobose, smooth.

Moreno et al. (1995) presented a macro- and microscopical study of this rare species, including SEM micrographs, based on collections from Baja California. This is the first report for *Schizostoma laceratum* from Chihuahua.

Scleroderma areolatum Ehrenb., Sylv. Mycol. Berol. (Berlin): 27 (1818)

Fig. 14

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Campus of Instituto de Ciencias Biomédicas, Centro de Idiomas, Univ. Autónoma Ciudad Juárez, in a garden with *Salix* sp., leg. M. Lizárraga, 26.IX. 2007, *UACJ 1084* in *AH 37813*.

Observations — Basidiome small, 1–5 cm in diam., surface bruising instantly purplish to reddish with 5% KOH, peridium with small brownish scales, without a stem or occasionally with a poorly defined pseudostipe. Spores 12–16 µm in diam., globose, densely spiny but not reticulate; with spines up to 2 µm long. Under SEM spore ornamentation seen to be formed by large, conical spines that rarely join at apex.

Sims et al. (1995) constructed a key to the genus based mainly on spore ornamentation (spinulose, subreticulate, or reticulate), after which Guzmán & Ovrebo (2000) proposed a new genus section and cited a new species in the American Continent. *Scleroderma areolatum* has been confused with *S. verrucosum* (Guzmán 1970), which is treated below.

First reported in Chihuahuan mycobiota by Quiñónez-Martínez et al. (1999) and Quiñónez-Martínez & Garza-Ocañas (2003).

Scleroderma cepa Pers., Syn. Meth. Fung. (Göttingen) 1: 155 (1801)

Specimens examined — **MEXICO. Chihuahua: Municipality of Chihuahua**, Cumbres de Májala, in oak-cypress wood, leg. M. Lizárraga & H. Pelayo, 15.XI.2003, *UACJ 1083* in *AH 37812*.

Observations — *Scleroderma cepa* is characterized by spinulose 9–12 µm broad spores and a smooth, white peridium that becomes pinkish-brown to dark brown when handled or becomes mature. The surface is often cracked or areolate but not with raised warts as in *S. citrinum* which can be further distinguished by reticulate rather than spinulose spores (Kuo, 2004).

Guzmán & Herrera (1973) and Pérez-Silva & Aguirre-Acosta (1986) previously reported *S. cepa* for Chihuahua.

Scleroderma verrucosum (Bull.) Pers., Syn. Meth. Fung. (Göttingen) 1: 154 (1801) Fig. 15

Specimens examined — **MEXICO. Chihuahua: Municipality of Guadalupe**, Sierra La Amargosa, associated with *Quercus* sp., *Prosopis* sp. and *Larrea tridentata*, leg. C. Arteaga, 28.X.2007, *UACJ 1085* in *AH 37814*.

Observations — Characterized by its fragile peridium (≤ 1 mm thick in the dry basidiome) with small scales at maturity, generally well-developed pseudostipe, globose 9–12 µm broad in spores, and episporium formed by thick pyramidal spines.

Pérez-Silva & Aguirre-Acosta (1986) and Laferriére & Gilbertson (1992) reported *S. verrucosum* for Chihuahua.

Tulostoma albicans V.S. White, Bull. Torrey Bot. Club 28: 428 (1901)

Specimens examined — **MEXICO. Chihuahua: Municipality of Casas Grandes**, Km 36 Casas Grandes to Cd. Juárez road, leg. D. Mejía, 7.X.2005, next to *Larrea tridentata*, *UACJ 1076* in *AH 37841*.

Observations — *Tulostoma albicans* is recognized by its thin but clearly membranous exoperidium, circular mouth, and spores that are 4.5–5.5 µm in diam., globose, smooth to verruculose. Under SEM the spore ornamentation appears as small and irregular verrucae, some of which are anastomosed (Esqueda et al. 2004).

This is the first report of this species from Chihuahua.

Tulostoma cretaceum Long, Mycologia 36: 321 (1944) Fig. 16

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Samalayuca, Rancho El Zorro Plateado, leg. T. Rubalcaba & G. García, 20.IV.2003, in sandy soil, *UACJ 1092* in *AH 37834*. Arroyo de Las Víboras, Sierra de Juárez, leg. A. Aguirre, 9.XII.2006, *UACJ 1066* in *AH 37835*.

Observations — Characterized by its whitish basidiome, hyphal exoperidium that is mixed with sand, fibrillose stoma that becomes indefinite when mature, cylindric stalk that arises from a conspicuous basal mycelial cord, filamentous branched septate capillitium, and smooth globose to subglobose spores 5–6 µm in diam.

When the fruiting body is enlarged, it can be confused with *Tulostoma obesum*, but that species generally has a straight stalk with a non-radicating (usually volviform) base, and capillitium broken into branches, seen under LM as dichotomous endings.

Known only from xeric areas in Baja California (Moreno et al. 1995) and Sonora (Esqueda et al. 2004). This is the first report of *T. cretaceum* for Chihuahua.

Tulostoma fimbriatum Fr., Syst. Mycol. 3: 43 (1829) Fig. 17

Specimens examined — **MEXICO. Chihuahua: Municipality of Ahumada**, El Sueco, Ejido Bellavista, next to *Larrea tridentata*, leg. J. Martínez, 21.VII.2001, *UACJ 1088* in *AH 37844*.

Observations — This taxon is recognized by its fimbriate stoma, hyphal exoperidium, and spores 5–6 µm in diam., globose, with verrucose and subreticulate ornamentation.

Within the genus *Tulostoma*, this is one of the most widely distributed species worldwide. This is the first report for *T. fimbriatum* from Chihuahua.

Tulostoma involucratum Long, Mycologia 36: 330 (1944) Fig. 18

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Valle de Juárez, Arroyo Cercano, next to *Larrea tridentata*, leg. J. Vargas, 6.VI.2000, *UACJ 1063* in *AH 37843*.

Observations — This species is characterized by its membranous exoperidium, tubular stoma, and echinulate spores [5–6(–7) µm diam] under LM and large compound verrucae under SEM. Specimens showed a conspicuous ellipsoid, short tubular stoma.

Esqueda et al. (2004) reported *T. involucratum* for the first time in Mexico; this is the first report for Chihuahua.

Tulostoma macrosporum G. Cunn., Proc. Linn. Soc. N.S.W. 50: 252 (1925) Fig. 19

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Cerro el Mesudo, Km 17.5 Ciudad Juárez to Janos road, in xerophytic scrub, leg. C. Salazar & M. Lizárraga, 23.V.2007, *UACJ 1073* in *AH 37827* and *UACJ 1156*. Ibidem, in sandy soil, leg. M. Vargas, R. Carrasco & D. Sáenz, 20.IV.2008, *UACJ 1079* in *AH 37826*.

Observations — This species is recognized by its short tubular stoma, thinly membranous exoperidium, and mainly because of its spore size [8–12(–14) µm in diam.]. Spore ornamentation is formed by thick spines which are occasionally joined forming a short wave under SEM.

Altés & Moreno (1999), who conducted type studies A study with type materials of *T. macrosporum*, *T. meridionale* J.E. Wright, and *T. utahense* J.E. Wright, recognized *T. macrosporum* and *T. utahense* as autonomous taxa, and synonymised *T. meridionale* with *T. utahense*.

Tulostoma macrosporum is little known in the Mexican mycobiota (Esqueda et al. 2004; Calonge et al. 2004, 2007). This is the first report for Chihuahua.

Tulostoma melanocyclum Bres., Ann. Mycol. 2: 415. 1904.

Specimens examined — **MEXICO. Chihuahua: Municipality of Madera**, zona Arqueológica de 40 Casas, in litter of *Quercus* sp., leg. A. Jiménez-Leyva, 23.VIII.2003, *UACJ 1075* in *AH 37825*.

Observations — *Tulostoma melanocyclum* is mainly recognized by its macroscopical similarity to *T. brumale* Pers. and spores [5–6.5 µm in diam.] that appear echinulate under LM and with large spines fused at the apex under SEM (Esqueda et al. 2004).

This is the first report of *T. melanocyclum* for Chihuahua.

Tulostoma obesum Cooke & Ellis, Grevillea 6: 82 (1878)

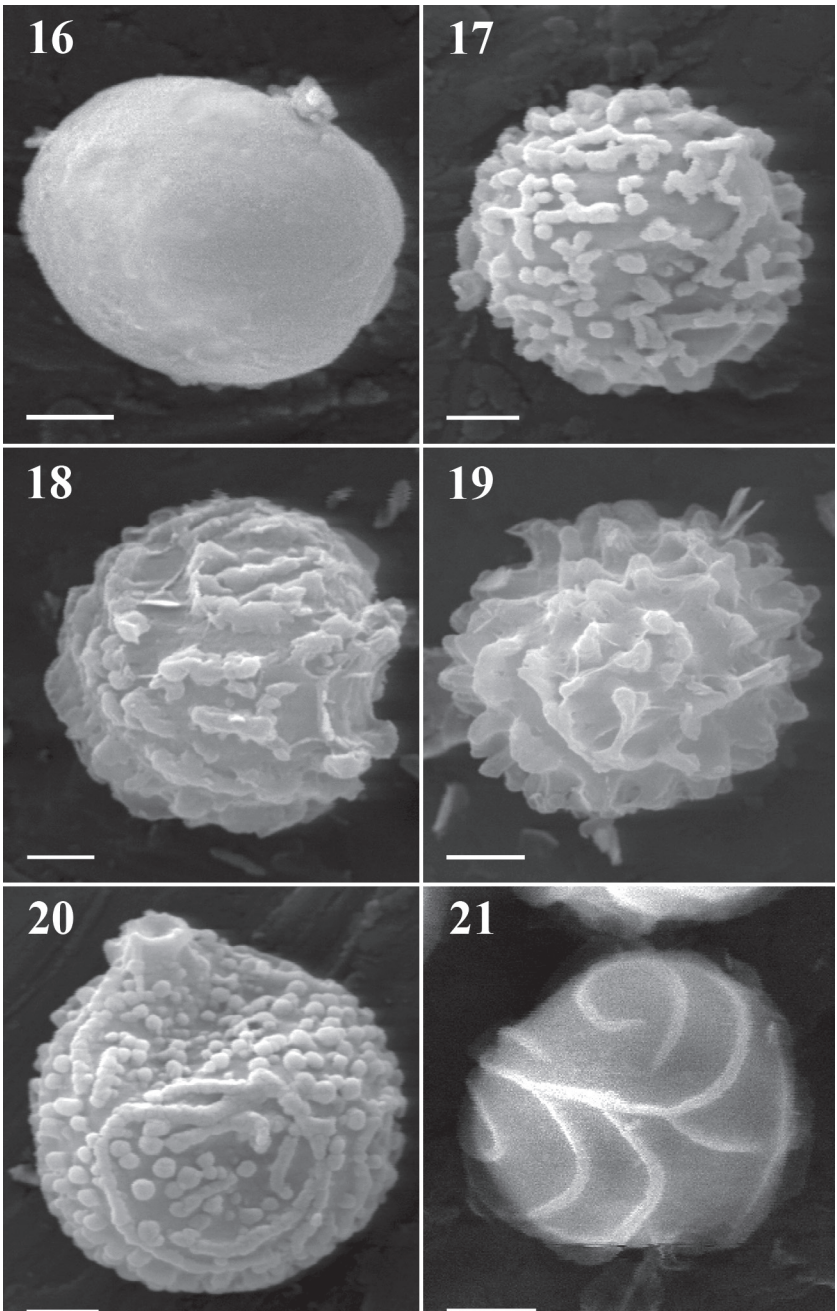
= *Tulostoma volvulatum* sensu auct., non *T. volvulatum* I.G. Borshch. (1865)

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Cerro el Mesudo, Km 17.5 Ciudad Juárez to Janos road, in xerophytic scrub, leg. C. Salazar & M. Lizárraga, 23.V.2007, *UACJ 1067* in *AH 37845*.

Observations — Basidiome whitish, stoma rapidly becoming indefinite when maturing, stalk generally with a volviform base; capillitium thick-walled, septate, fragile, spores smooth, globose and frequently deformed shape, 5–6 µm in diam.

Altés et al. (1999) have summarized the taxonomic difficulties surrounding *T. obesum*. The species was known only in the Mexican mycobiota for Sonora (Esqueda et al. 2004), and this is the first report for Chihuahua.

Fig. 16: *Tulostoma cretaceum* AH 37835. Spore. Fig. 17: *T. fimbriatum* AH 37844. Spore. Fig. 18: *T. involucratum* AH 37843. Spore. Fig. 19: *T. macrosporum* AH 37826. Spore. Fig. 20: *T. pulchellum* var. *subfuscum* AH 37835. Spore. Fig. 21: *T. striatum* AH 37838. Spore. Scale bar 16–18, 20–21 = 1 µm; 19 = 2 µm.


16
17
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Tulostoma pulchellum* var. *subfuscum (V.S. White) J.E. Wright, G. Moreno & Altés, Mycotaxon 43: 483 (1992) Fig. 20

≡ *Tulostoma subfuscum* V.S. White, Bull. Torrey Bot. Club 28: 433 (1901)

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez** San Jerónimo, Km 10 Ascensión to Ciudad Juárez road, next to *Prosopis glandulosa*, leg. R. Martínez, 23.IV.2002, *UACJ 1071* in *AH 37835*.

Observations — Recognized by its clearly membranous exoperidium, fibrillose, fimbriate and scutellate stoma, and basidiospores that are 4.5–6 µm in diam. and seen under SEM with dense verrucae and waves of variable length and shape.

This taxon is macro- and microscopically similar to *Tulostoma pulchellum* Sacc., which is distinguished by a spore ornamentation that is also verrucose but lacks waves. For this reason, Moreno et al. (1992) proposed it as a variety of *T. pulchellum* as originally suggested by Wright (1987). Calonge et al. (2004) recently reported the variety for Mexico based on a single incomplete basidiome from Baja California. The Chihuahuan collection has four complete basidiomes and one spore sac.

Tulostoma striatum G. Cunn., Proc. Linn. Soc. N.S.W. 50: 255 (1925) Fig. 21

Specimens examined — **MEXICO. Chihuahua: Municipality of Juárez**, Valle de Juárez, Ejido El Millón, in sandy soil, leg. T. Rubalcaba, J. Martínez, M. Ramírez & C. Muñoz, 19.IX.2001, *UACJ 1089* in *AH 37838*.

Observations — This species is distinguished by the usually obese spore sac, a rather short stipe, a clearly membranous exoperidium, fibrillose-fimbriate stoma, and spores [5–6.5 µm in diam.] with striate ornamentation (Esqueda et al. 2004). Although *T. striatum* is represented by only one spore sac in the UACJ herbarium, the typical basidiospore size (4–6 µm in diam.) and ornamentation is sufficient to confirm its identity.

This is the first record for *Tulostoma striatum* from Chihuahua.

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